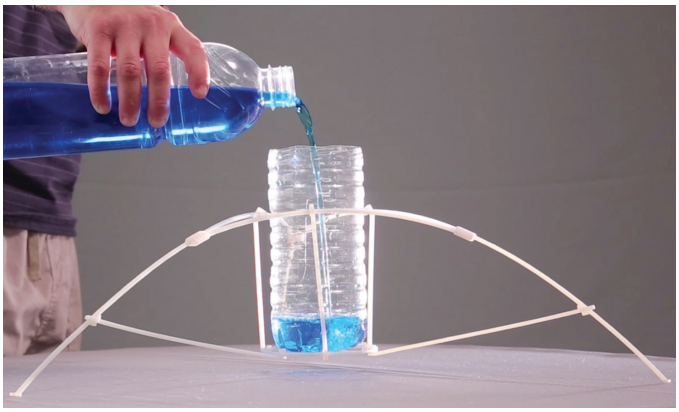
LESSON GUIDE

WEIGHT-SUPPORTING STRUCTURE CHALLENGE



Level	Advanced
Academic Connections	Engineering, Design Thinking, Hands-On Learning, Science, Design for Manufacturability
Core Concepts	Engineering Analysis, Engineering Design, Print Optimization, Computer Aided Design (CAD)
Duration	2-3 weeks

In this challenge, the goal will be to build a structure that can support a weight suspended above a surface.

LEARNING OBJECTIVES

By the end of this workshop, the student will be able to:

- Design, print, and test a structure that supports a weight above a certain height (2 cm recommended).

ESSENTIAL QUESTIONS

1. What can you learn from the design of existing support structures?
   a. Bridges
   b. Cranes
   c. Tripods
   d. Tensegrity structures
2. How are the problems these structures are designed to solve similar to the current challenge and in what ways are they different?
3. What are the common features of these structures? How can they be applied to the challenge?
4. How can 3D printing technology allow you to create more effective designs (complex shapes and profiles, weight savings by "trimming" non-load bearing areas)?

REQUIREMENTS

- Educator PC with access to:
  - Microsoft PowerPoint
  - QuickTime
  - Internet connection
- Projector
- 3D printers
- CAD design tool

LESSON GUIDELINES

- Build a structure that can support a weight that is suspended 2 cm above the surface. The structure can touch the surface only at points of contact that are 30 cm or more away from the center.
- Measure the load bearing capacity of the structure (place a cup or bottle in the holder and fill it up slowly until the structure breaks off and the center touches the surface).
- The center of the structure must have a cup/bottle holder 10 cm in diameter and 2 cm above the surface.
- Maximum weight for the entire structure is limited to less than 50 g.
- Only printed parts are allowed - no adhesives, screws, etc.

CHALLENGE OVERVIEW

We have included guidance for this challenge, as well as design tips, and additional material on our education webpage, including a video. http://www.stratasys.com/3DLC

DESIGN TIPS FOR FDM®

1. The minimal wall thickness varies depending on the layer thickness. For load bearing parts, the minimum wall thickness is approximately the width of two contours.
2. If the required structure is too big to fit on a single printer tray, the unit must be made of multiple parts. No adhesive is allowed in this challenge so some type of printed connector must be used. Connectors can be based on friction, snaps or forces that form when the structure is loaded. As a design rule of thumb, leave a clearance of 0.31 - 0.51 mm (0.012 -0.020 in.) between parts in the X/Y-axis (machine dependent – please reference Best Practices – Building Assembly Parts, available in the Advanced Applications section at http://www.stratasys.com/3DLC). Clearance equal to at least double the layer thickness for the Z-axis is recommended.
3. After you have an initial design that works – refine it. See where the load is concentrated and how these areas can be made stronger and where load and weight can be saved. Consider creating a more complex structure (beams that are hollow tubes, utilize different infills, custom groups, or concentrate material in areas of higher stress).

4. Know the material limitations. Look at the datasheet; print a simple model to feel in your hand and design accordingly.
5. You can estimate the structure's weight using the built-in function in the CAD software. This can allow you to compare designs without printing them. You may need to print a test part to calibrate the density value in the software to get realistic weight estimations.

OPTIONAL

1. Use mechanical analysis/simulation software to help you compare and optimize your design.
2. Print prototypes of your design, test them and improve accordingly.

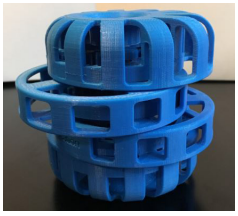
SUGGESTED NEXT LESSONS

GOLF PUTTER

Design a golf putter and explore moment of inertia and how it affects a putter's action when striking the ball. Use the swing weight scale and the putter's length to determine the approximate head weights that will be needed for the design.

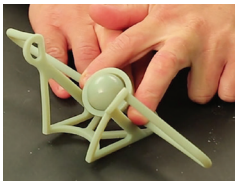
GEAR SYSTEM

Students will explore gear systems in 2D and 3D models while learning about speed, force, motion, tolerance, and layer thickness.



CATAPULT

Design a catapult that can throw a 3D printed ball as far as possible.



To access additional 3D Learning Content and resources visit:

http:// www.stratasys.com/3DLC

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HEADQUARTERS

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)